WE CLAIM:

1. A method for forming arrays of metal, alloy, semiconductor and/or magnetic clusters, comprising:

placing a scaffold on a substrate; and

coupling monodispersed clusters, selected from the group consisting of metal clusters, alloy clusters, semiconductor clusters, magnetic clusters, and combinations thereof, to the scaffold.

2. The method of claim 1, wherein coupling comprises contacting the scaffold with clusters having plural exchangeable ligands, where at least one of the ligands is exchanged for a functional group of the scaffold.

3. The method of claim 1, wherein coupling comprises contacting the scaffold with clusters having plural ligands, where at least one of the ligands is charged and is electrostatically attracted to a scaffold of opposite charge.

4. The method of claim 3, wherein the scaffold is positively charged polylysine and the plural ligands of the clusters include at least one having a negatively charged group.

5. The method of claim 4, wherein the negatively charged group is selected from the group consisting of carboxylate, sulfonate, and combinations thereof.

6. The method of claim 4, wherein the polylysine is poly-L-lysine.

7. The method of claim 3, wherein the scaffold is a polynucleotide having a negatively charged phosphate backbone and the plural ligands of the clusters include at

least one having a positively charged group selected from the group consisting of protonated amine groups, quaternary ammonium groups, and combinations thereof.

8. The method of claim 1, wherein coupling comprises contacting the scaffold with clusters having plural ligands, where at least one of the ligands becomes associated with the scaffold through a hydrophobic interaction.

9. The method of claim 8, wherein the scaffold is a polynucleotide and the plural ligands of the clusters include at least one ligand that intercalates into the polynucleotide.

10. The method of claim 9, wherein the polynucleotide is DNA.

11. The method of claim 1, wherein placing the scaffold on the substrate comprises placing the scaffold on the substrate in a predetermined pattern.

12. The method of claim 11, wherein placing the scaffold on the substrate in a predetermined pattern comprises aligning the scaffold in an electric field created between electrodes on the substrate.

13. The method of claim 12, wherein the scaffold has an electric dipole moment that causes the scaffold to align in the electric field.

14. The method of claim 13, wherein the scaffold is a helical polynucleotide.

15. The method of claim 13, wherein the scaffold is a helical polypeptide.

16. The method of claim 15, wherein the helical polypeptide is in the form of an α-helix.

17. The method of claim 16, wherein the polypeptide is polylysine.

18. The method of claim 11, wherein placing the scaffold on the substrate in a predetermined pattern comprises polymerizing monomers, oligomers, or polypeptides into larger polypeptides to form a scaffold between two electrodes on the surface of the substrate.

19. The method of claim 11, wherein placing the scaffold on the substrate in a predetermined pattern comprises anchoring the scaffold and inducing alignment of the anchored scaffold in a particular direction by fluid flow.

20. The method of claim 19, wherein the scaffold is attached to a first electrode and aligned by fluid flow, substantially in the direction of a second electrode.

21. The method of claim 20, wherein a second scaffold is attached to a third electrode and aligned by fluid flow such that the second scaffold crosses the scaffold aligned between the first and second electrodes.

22. The method of claim 21, wherein the second scaffold is aligned between the third electrode and a fourth electrode.

23. The method of claim 10, wherein placing the scaffold on the substrate in a predetermined pattern comprises aligning a scaffold having a magnetic moment in a magnetic field.

24. The method of claim 1, wherein the clusters comprise metal clusters, and the metal is selected from the group consisting of Au, Ag, Pt, Pd, and mixtures thereof.

25. The method according to claim 24, wherein the metal cluster is Au_{55}.

26. The method according to claim 1, wherein the scaffold comprises molecules selected from the group consisting of polynucleotides, polypeptides, and mixtures thereof.

27. The method according to claim 26, wherein the scaffold comprises polypeptides capable of forming α helices.

28. The method according to claim 27, wherein the polypeptide is polylysine.

29. The method according to claim 1, wherein the clusters are semiconductors selected from the group consisting of cadmium selenide, zinc selenide, cadmium sulfide, cadmium telluride, cadmium-mercury-telluride, zinc telluride, gallium arsenide, indium arsenide and lead sulfide.

30. The method according to claim 1, wherein placing the scaffold comprises aligning the polypeptides between electrodes on the substrate.

31. The method according to claim 1, wherein placing the scaffold on the substrate comprises polymerizing monomers, oligomers or polypeptides into larger polypeptides on the substrate.

32. A method for forming arrays of metal clusters, comprising:

placing a scaffold on a substrate, the scaffold comprising molecules selected from the group consisting of polynucleotides, polypeptides, and mixtures thereof; and

forming arrays by contacting the scaffold with plural monodispersed ligand-stabilized metal clusters, the metal being selected from the group consisting of Ag, Au, Pt, Pd and mixtures thereof, the clusters being coupled to the scaffold.

33. The method according to claim 32, wherein the scaffold comprises polypeptides capable of forming α helices.

34. The method according to claim 33, wherein the polypeptide is polylysine.

35. The method according to claim 32, wherein the scaffold is DNA.

36. The method according to claim 35, wherein the DNA is a Holliday junction.

37. The method according to claim 32, wherein the clusters are coupled to the scaffold by a coupling method selected from the group consisting of ligand exchange reactions, electrostatic interactions, hydrophobic interactions, intercalation interactions, covalent bonds, and combinations thereof.

38. The method according to claim 32, wherein placing the scaffold on the substrate comprises aligning the scaffold between electrodes on the substrate.

39. The method according to claim 38, wherein aligning the scaffold between electrodes comprises aligning the scaffold by creating an electric field between the electrodes.

40. The method according to claim 38, wherein aligning the scaffold between electrodes comprises aligning the scaffold by anchoring a first end of the scaffold to a first electrode and creating fluid flow in the direction of a second electrode such that the scaffold becomes substantially aligned with the direction between the first and second electrodes.

41. The method according to claim 38, wherein placing the scaffold on the substrate comprises polymerizing monomers, oligomers or polypeptides into larger polypeptides between electrodes on the substrate.

42. A composition, comprising:

a polypeptide capable of forming α-helix; and

plural monodispersed clusters, each cluster having plural ligands that serve to couple the clusters to the polypeptide.

43. The composition of claim 42, wherein the plural ligands of the clusters interact with the polypeptide by an interaction selected from the group consisting of ligand exchange reactions, electrostatic interactions, hydrophobic interactions, and combinations thereof.

44. The composition according to claim 42, wherein the clusters comprise metal and/or semiconductor clusters having radii of from about 0.4 nm to about 1.8 nm.

45. The composition according to claim 44, wherein the metal and/or semiconductor clusters have radii of from about 0.4 to about 1.0 nm.

46. The composition according to claim 42, wherein the clusters comprise metal clusters, and the metal is selected from the group consisting of Au, Ag, Pt, Pd and mixtures thereof.

47. The composition according to claim 46, comprising Au_{55} metal clusters.

48. A composition, comprising:

a polynucleotide capable of forming a helical structure; and

plural monodispersed clusters, each cluster having plural ligands that serve to couple the clusters to the polynucleotide.

49. The composition of claim 48, wherein the plural ligands of the clusters interact with the polynucleotide by an interaction selected from the group consisting of ligand exchange reactions, electrostatic interactions, hydrophobic interaction, intercalation reactions and combinations thereof.

50. The composition according to claim 48, wherein the clusters comprise metal and/or semiconductor clusters having radii of from about 0.4 nm to about 1.8 nm.

51. The composition according to claim 48, wherein the clusters comprise metal clusters, and the metal is selected from the group consisting of Au, Ag, Pt, Pd and mixtures thereof.

52. An organized array of metal clusters, comprising:

monodispersed, ligand-stabilized metal clusters having metal-cluster radii of from about 0.4 nm to about 1.8 nm, the metal being selected from the group consisting of Ag, Au, Pt, Pd and mixtures thereof; and

a scaffold, the metal clusters being coupled to the scaffold to form an organized array.

53. The array according to claim 52, wherein the scaffold comprises molecules selected from the group consisting of polynucleotides, polypeptides, and mixtures thereof.

54. The array according to claim 53, wherein the scaffold comprises polypeptides capable of forming α helices.

55. The array according to claim 53, wherein the scaffold comprises helical DNA.

56. An electronic device that operates at or about room temperature based on the Coulomb blockade effect, comprising:

a first cluster comprising a metal cluster core having a radius of between about 0.4 nm and about 1.8 nm; and

a second such cluster physically spaced apart from the first metal cluster at a distance of less than about 5 nm, where the physical separation between the first and second clusters is maintained by the clusters being coupled to a biomolecular scaffold.

57. The electronic device of claim 56, comprising first and second biomolecular scaffolds, each with coupled clusters, where the first and second scaffolds intersect.

58. The electronic device of claim 56, where the device exhibits a linear increase in the number of electrons passing between the first and second clusters as the potential difference between the two clusters is increased above a threshold value.

59. A method of synthesizing phosphine-stabilized gold nanoparticles, comprising:

dissolving $HAuCl_4$ and PPh_3 in a biphasic system, the biphasic system comprising a water phase, an organic phase, and a phase transfer catalyst; and

adding sodium borohydride to the biphasic system.

60. The method of claim 59, wherein the biphasic system comprises water and an organic solvent selected from the group consisting of toluene, xylenes, benzene, and mixtures thereof.

61. The method of claim 59, wherein the phase transfer catalyst is a quaternary ammonium salt.

62. The method of claim 61, wherein the phase transfer catalyst is tetraoctylammonium bromide.

63. The method of claim 59, wherein the size of the phosphine-stabilized gold nanoparticles may be controlled by the rate at which sodium borohydride is added to the biphasic system.

64. A method of preparing thiol-stabilized gold nanoparticles, comprising:
dissolving a phosphine-stabilized gold nanoparticle in an organic solvent; and
exchanging the phosphine ligands of the phosphine-stabilized gold nanoparticle for thiol ligands, the thiol ligands further comprising a group of atoms that is capable of coupling the thiol-stabilized gold nanoparticle to a scaffold.

65. The method of claim 64, wherein exchanging the phosphine ligands for thiol ligands comprises dissolving the thiol ligand in the organic solvent.

66. The method of claim 65, wherein the organic solvent is water-immiscible and exchanging the phosphine ligands for thiol ligands comprises dissolving the thiol ligand in water and contacting the water with the organic solvent to form a biphasic system.